P/00/001
Section 29

AUSTRALIA
Patents Act 1990

PATENT REQUEST : STANDARD PATENT

The person identified below as the Applicant requests the grant of a patent to the person identified below as the Nominated Person, for an invention described in the accompanying standard complete specification.

Applicant:	UTILUX PTY LIMITED ACN: 003 070 148
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Nominated Person:	UTILUX PTY LIMITED
Address:	14 Commercial Road, KINGSGROVE NEW SOUTH WALES 2208, AUSTRALIA
Invention Title:	Electrical Connector
Name of Actual Inventor:	Gregg Thomas Smith
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Attorney Code:	GH

ASSOCIATED PROVISIONAL APPLICATION DETAILS

Application No:	PM1613
Date:	1st October, 1993

Drawing number recommended to accompany the abstract: 2

DATED this 30th day of September 1994

UTILUX PTY LIMITED
By their Patent Attorney

GRIFFITH HACK & CO

S 049840 300994

411/14589-GO

P/00/008
Section 29(1)
Regulation 3.1(2)

AUSTRALIA
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NOTICE OF ENTITLEMENT

We UTILUX PTY LIMITED

of 14 Commercial Road, Kingsgrove, New South Wales, 2208, Australia

being the Applicant and Nominated Person, in respect of Application No. 74379/94 , entitled state the following:

GREGG THOMAS SMITH is the actual inventor of the invention.

This application is associated with the following provisional application(s):

Applicant	**Application No**	**Application Date**
UTILUX PTY LIMITED	PM1613	1st October 1993

The inventor made the invention for and on behalf of the nominated person in the course of his duty as an employee of the nominated person.

DATED this 22nd day of June 1998

UTILUX PTY LIMITED
By their Patent Attorney

GRIFFITH HACK

OUR REF: P14589-GO TJS/MS

AU9474379

(12) PATENT ABRIDGMENT (11) Document No. AU-B-74379/94
(19) AUSTRALIAN PATENT OFFICE (10) Acceptance No. 695492

(54) Title
ELECTRICAL CONNECTOR

(51)[5] International Patent Classification(s)
H01R 004/20

(21) Application No. : **74379/94** (22) Application Date : **30.09.94**

(30) Priority Data

(31) Number	(32) Date	(33) Country
PM1613	**01.10.93**	**AU AUSTRALIA**

(43) Publication Date : **13.04.95**

(44) Publication Date of Accepted Application : **13.08.98**

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(56) Prior Art Documents
AU 35522/93
AU 26574/54
AU 14617/88

(57) Claim

1. An electrical connector for connecting an end of a power conductor to another member, comprising a first part having a passageway therein for receiving the end of a power conductor, and a second part arranged to be connected to the other member, the first and second parts being electrically connectable and being rotatable relative to each other, the second part comprising a first portion adapted to be connected to the other member and a second portion comprising a body portion having a cavity extending therein, the first part comprising a sleeve which is shaped and configured to fit into the cavity and to be rotatable therein through a range of positions, the passageway in the sleeve being shaped and dimensioned to accommodate the end portion of an electrical power conductor, whereby to enable a power conductor having a first orientation to be connected to another member having a second orientation, the sleeve having a plurality of abrasive surfaces within the passageway whereby to assist in removing oxide from the surface of the conductor during crimping.

2. An electrical connector in accordance with claim 1, the cross-sectional shape of the passageway within

.../2

the sleeve being different from the cross-sectional shape of the external surface of the body portion, whereby the cross-sectional shape of the external surface of the body portion may be suited for use with particular crimping tools and the internal cross-sectional shape of the passageway in the sleeve may be suited to electrical power conductors of particular cross-sectional shapes.

9. A method of electrically connecting an end of a power conductor having a first orientation to another member having a second orientation, comprising the steps of providing an electrical connector comprising a body having a first portion adapted to be connected to the other member and a second portion comprising a body portion having a cavity extending therein, and a sleeve shaped and configured to fit into the cavity and to be rotatable therein through a range of positions, the sleeve having a passageway therein shaped and dimensioned to accommodate the end of the electrical power conductor and the sleeve having a plurality of abrasive surfaces within the passageway whereby to assist in removing oxide from the surface of the conductor during crimping, placing the end of the electrical power conductor within the passageway in the sleeve, rotating the sleeve relative to the body portion if there is any difference between the first and second orientations to take into account the difference between the first and second orientations, crimping the body portion of the connector and the sleeve to the end of the power cable, and securing the first portion to the other member to provide an electrical connection.

P/00/011
Regulation 3.2

AUSTRALIA

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ORIGINAL

COMPLETE SPECIFICATION

STANDARD PATENT

Invention Title: Electrical Connector

The following statement is a full description of this invention, including the best method of performing it known to us:

GH&CO REF: P14589-GO:TJS:JM

ELECTRICAL CONNECTOR

The present invention relates to an electrical connector, and in particular to an electrical connector for connecting an end of an electrical power cable to another member.

Electrical connectors are required for the connection of power distribution conductors to power distribution boards. In the past, electrical power conductors have generally been of a circular cross-section. Prior art electrical connectors therefore generally comprise a body having a cylindrical first end portion with a substantially circular cross-section passage therein for receiving an end of the circular cross-section power conductor. The second end portion of the body comprises an extending lug portion known as a "palm" arranged to be clamped to a power distribution board. In order to achieve good electrical connection between the power conductor and the connector it is known to employ a crimping device to compress the cylindrical first end portion of the connector onto the conductor end. These known crimping devices exert large pressures and create, in effect, a "cold weld" between the connector and conductor. Extremely good mechanical and electrical contact between the end of a power conductor and the distribution board connector is essential. Any defect in the electrical connection can cause conduction problems and is potentially dangerous.

To ensure adequate electrical connection the crimping devices in use are arranged to exert large pressures on the first end portion of the connector, in the order of 10,000 psi. The cross-section of the die of the crimping tool is hexagonal. This was found to provide the best cold weld for the traditional circular cross-section power conductors.

In more recent times it has become common practice to provide aluminium power conductors having cross-sectional shapes resembling that of a segment of a circle. Aluminium is cheaper than copper and the circle segment cross-sectional shape enables three or four or more

power conductors to be married in a multiple core composite power conductor.

Connection of the ends of such circle segment cross-section conductors to electrical connectors presents a problem. Using the traditional electrical connector with the circular cross-section passageway in the first end portion is not a possibility, as such a connector is not able to be "crimped" onto the circle segment cross-sectional end to provide adequate mechanical and electrical connection between the connector and the power conductor, particularly when using traditional hexagonal cross-section crimping dies. It should be noted that a large investment has been made in crimping tools and it is not desirable to have to alter the crimping tools available or provide new crimping tools to deal with electrical connectors having different outer cross-sectional shapes.

To overcome the problem of bad electrical and mechanical connection, an electrical connector has been proposed which has a first end portion which has an external circular-cross-sectional shape and which has an internal passageway of circle segment cross-sectional shape to receive the end of an aluminium power conductor of the same shape. Good mechanical and electrical connection can be achieved between such electrical connectors and power conductors, with conventional crimping tools. A further problem arises using such connectors, however. Power conductors are often laid out underground and arrive at the distribution point with different orientations. As the distribution board will be of a particular orientation, to fit the end of such a circle segment conductor into a connector having a circle segment cross-section and connect the connector to the power distribution board it is often necessary to have to twist the conductor so that the orientation of the conductor conforms with the orientation of the distribution board. Twisting the cable is, firstly, very difficult (these cables are often half an inch in diameter and of solid metal) and, secondly, can give rise to conduction problems in the power conductor.

A number of electrical connectors have been proposed to try and solve this problem, but none have been completely successful. All require some compromise between the necessity to twist the conductor and the adequacy of the mechanical and electrical connection provided by crimping.

From a first aspect, the present invention provides an electrical connector for connecting an end of a power conductor to another member, comprising a first part having a passageway therein for receiving the end of a power conductor, and a second part arranged to be connected to the other member, the first and second parts being electrically connectable and being rotatable relative to each other, the second part comprising a first portion adapted to be connected to the other member and a second portion comprising a body portion having a cavity extending therein, the first part comprising a sleeve which is shaped and configured to fit into the cavity and to be rotatable therein through a range of positions, the passageway in the sleeve being shaped and dimensioned to accommodate the end portion of an electrical power conductor, whereby to enable a power conductor having a first orientation to be connected to another member having a second orientation, the sleeve having a plurality of abrasive surfaces within the passageway whereby to assist in removing oxide from the surface of the conductor during crimping.

The passageway preferably has a cross-section perpendicular to its longitudinal axis which is of a different shape to the equivalent external cross-section of the body portion.

The rotatable sleeve preferably enables any cross-sectional shape conductor end to be fitted to the connector and the connector to be fitted to a distribution board, for example, without requiring any twisting of the conductor. Further, the inner cross-sectional shape of the sleeve can be of any desired shape and is preferably designed to provide optimum mechanical and electrical

connection after the application of a conventional crimping tool to the connector. For example, the passage in the sleeve may be of a similar shape cross-section to the circle segment cross-section of modern power conductors. The fact that the sleeve is rotatable means that it is, preferably, not necessary to twist the conductor to insert the conductor end within the passage in the sleeve, notwithstanding the final orientation required by the connector, to fit to a distribution board, for example.

The exterior of the sleeve is preferably cylindrical and fits within a cylindrical cavity in the body portion, to enable the sleeve to be rotatable within the body portion and close fitting thereto, to ensure good electrical connection and mechanical connection between the body portion and the sleeve following application of a crimping tool.

The external cross-sectional shape of the body portion is preferably cylindrical, to facilitate use with known crimping tools. The cross-sectional shape of the passageway within the sleeve will generally preferably be different to the external cross-sectional shape of the body portion.

The sleeve may have a plurality of ribs extending along its outside, the ribs being dimensioned to cause an interference fit with the interior of the cavity, but enabling rotation of the sleeve within the cavity. The sleeve will therefore tend to be retained within the cavity before crimping, but will still be rotatable therein.

Alternatively, the sleeve may be retained within the interior of the cavity by the provision of a conductive grease filling the interstices between the external wall of the sleeve and the internal wall of the cavity. An example of such a grease is Almonox.

The sleeve can preferably be rotated through 360° within the body portion.

The internal wall of the passageway within the sleeve has a plurality of abrasive surfaces to assist in removing oxide from the surface of the conductor during

crimping. This is particularly advantageous for conductor materials which form oxides, such as aluminium. Preferably, the sleeve has a plurality of slots extending axially along its walls, the corners of the slots providing the abrasive surfaces. The slots preferably extend through the walls such that, on crimping, surfaces of the conductor will come into contact with the internal walls of the cavity within the body portion, facilitating good electrical contact.

The first portion of the connector may be adapted for connection to any other member to which it is required to electrically connect a power conductor. For example, the first portion may be a "palm" for connection to a power distribution board.

In one embodiment, the first portion comprises a further body portion having a passage extending therein, the passage being shaped and dimensioned to accommodate an end portion of an electrical power conductor. Such a connector enables the connection of one power conductor to another, for example, to provide a link between conductors.

The present invention further provides a method of electrically connecting an end of a power conductor having a first orientation to another member having a second orientation, comprising the steps of providing an electrical connector comprising a body having a first portion adapted to be connected to the other member and a second portion comprising a body portion having a cavity extending therein, and a sleeve shaped and configured to fit into the cavity and to be rotatable therein through a range of positions, the sleeve having a passageway therein shaped and dimensioned to accommodate the end of the electrical power conductor and the sleeve having a plurality of abrasive surfaces within the passageway whereby to assist in removing oxide from the surface of the conductor during crimping, placing the end of the electrical power conductor within the passageway in the sleeve, rotating the sleeve relative to the body portion if there is any difference between the first and second

orientations to take into account the difference between the first and second orientations, crimping the body portion of the connector and the sleeve to the end of the power cable, and securing the first portion to the other member to provide an electrical connection.

Features and advantages of the present invention will become apparent from the following description of embodiments thereof, by way of example only, with reference to the accompanying drawings, in which;

Figure 1 is a side view in partial longitudinal section of an electrical connector in accordance with an embodiment of the present invention;

Figure 2 is an end view from one end of the connector of Figure 1;

Figure 3 is a side view of an electrical connector in accordance with a further embodiment of the invention, shown partially in longitudinal cross-section;

Figure 4 is a view from one end of the connector of Figure 3;

Figure 5 is a view from the other end of the connector of Figure 3;

Figure 6 is a detail section-view through the electrical connector of Figures 1 and 2;

Figure 7 is a side view of an alternative sleeve arrangement for use with the embodiments of figures 1 through 6; and

Figure 8 is an end view from the open end of the sleeve of figure 7.

Referring firstly to Figures 1 and 2, the electrical connector illustrated comprises a first part 1, in the form of a cylindrical sleeve in the illustrated embodiment, and a second part 2. The first part 1 has a passageway 3 therein for receiving an end of an electrical power conductor (not shown). First part 1 and second part 2 are rotatable relative to each other, to enable a conductor having a first orientation to be connected to another member having a second orientation, preferably without it being necessary to deform the conductor by

twisting it to match the second orientation.

In more detail, the electrical connector comprises a first end portion 4 comprising a "palm" securable to a power distribution board. A second end portion 5, comprises a cylindrical body portion 6 having a cavity 7 extended therein into which the sleeve 1 fits. The passage 3 is shaped and dimensioned to accommodate the end portion of an electrical power conductor. In the illustrated embodiment the cavity is of circle segment cross-section for the accommodation of a single core of 4-core circle segment cross-section aluminium power cable.

The cavity 7 and the outside of the sleeve 1 have substantially circular cross-sections to enable relative rotation between the parts 1 and 2 of 360°. To provide an interference fit of the sleeve 1 in the cavity 7, a plurality of ribs are provided extending longitudinally down the outer surface of the sleeve 1, the ribs being dimensioned to cause an interference fit of the sleeve 1 within the cavity 7. The ribs are dimensioned so as to prevent the sleeve 1 falling out of the cavity 7 during normal handling but also to allow for rotation when a rotating force is applied.

Figure 6 shows a cross-sectional detail through the second end portion 5 to show rib 20 which provides the interference fit between the sleeve 1 and body portion 6. Two ribs are provided on the sleeve 1 of this embodiment.

As a preferred alternative to the ribs, the sleeve 1 may be absent ribs and may be retained within the cavity 7 by the provision of a conductive grease, such as Almonox. It is advantageous in any case that the conductive grease be provided. For aluminium conductors, at least the sleeve 1 and body portion 6 will preferably be of aluminium. The provision of a conductive grease on the internal surfaces of the cavity and the external surfaces of the sleeve may assist in reducing the extent of formation of oxide. The body portion 6 of the figure 1 and 2 embodiment is preferably of bi-metal. End 4 is preferably of copper while body portion 6 is preferably of

aluminium. Sleeve 1 is also preferably of aluminium. Obviously, where other materials are used for the conductive cable the materials used for the connector may be varied.

In operation, an end of an aluminium power conductor, which may be a ground laid conductor which it is desired to connect to a power distribution board, is placed within the cavity in the sleeve 3. The palm 4 is then fixed to a power distribution board. The relative rotation of the parts 1 and 2 enables an easy fit to the power distribution board no matter what relative orientations of the conductor and distribution board. A standard crimping tool is then applied to the external surface of the portion 5 to create a cold weld between the power conductor and the connector. Good mechanical and electrical connection is enabled because the cross-sectional shape of the passageway 3 is able to be configured to provide a good match to the cross-sectional shape of the end of the power conductor.

Figures 3 to 5 show a further embodiment of an electrical connector in accordance with the present invention, for connecting two ends of power conductors, for example to connect one power conductor to another, providing a "link" function. The same reference numerals as used in Figures 1 and 2 are used for corresponding components in Figures 3, 4 and 5. One end portion of the link connector of Figures 3, 4 and 5 corresponds to the end portion 5 of the connector of Figures 1 and 2, and comprises a cylindrical body portion 6 having a cavity 7 extending therein and a sleeve 1 configured to fit into the cavity and to be rotatable therein. Sleeve 1 has a passageway 3 therein shaped and dimensioned to accommodate an end of an electrical power conductor. The second end portion of the link connector, however, does not comprise a palm for connection to a power distribution board, but comprises a further cylindrical body portion 10 having a passageway 11 therein which is shaped and dimensioned to accommodate an end portion of a further power conductor. This further cylindrical body portion 10 does not have a

rotatable sleeve mounted therein. The cross-sectional shape of the passageway 3 and the sleeve 1 and the passageway 11 in the further cylindrical body portion 10 are both circle segment cross-section to accommodate circle segment cross-section aluminium power conductors.

In operation, an end of an aluminium conductor requiring connection to an end of a further aluminium conductor is inserted into the passageway 3 and the sleeve 1. The end of the further aluminium conductor is then inserted into passageway 11 in the further cylindrical body portion 10. Relative orientations of the ends of the conductors are irrelevant, as the relative rotation between the parts 1 and 2 enables the connector to be fitted to the ends of the conductors no matter what the relative orientation. A crimping tool is then applied to the connector to cold weld the connector to the ends of the conductors. A good mechanical and electrical connection is achievable because the cross-sectional shape of the passageway in the sleeve portion and the passageway 11 in the further cylindrical end portion may be optimum for good crimping performance.

An example of a process of securing an electrical connection using the connector is as follows;

a) Strip outer insulation from cable core to expose the bare conductor
b) Remove connection from packaging
c) Manipulate conductor to a suitable position
d) If aluminium conductor, scratch brush conductor surface thoroughly with suitable brush
e) Place connector on conductor, and orient connector to correct plane
f) Crimp connector to conductor using suitable tools and crimping dies
g) Secure connector to stud or node with suitable mechanical fasteners.

If required, the second end portion of the link connector may also contain a rotatable sleeve, similar to the first end portion.

The cross-sectional shape of the passageway in the sleeve portion may vary depending upon cross-sectional shape of the power conductors which it is required to fit to the electrical connector. The invention is not limited to an electrical connector suitable for use with circle segment cross-sectional conductors. The invention can be adapted for use with any cross-sectional conductor.

The external cross-section of the second portion (the conductor end portion) may be of any cross-sectional shape to suit any type of crimping device. Cylindrical external cross-section is preferred to suit traditional crimping devices.

An alternative preferred embodiment of a sleeve for use the connector of previous embodiments is illustrated in figure 7 and figure 8. The sleeve 1A has thinner walls than the sleeve 1 of previous embodiments and, in fact, has a plurality of slots 20 extending axially along and through the walls 21 of the sleeve 1A. These slots 20 have a dual purpose. Firstly, the corners 22 of the slots act as sharp edges and operate to break oxide on the surface of the aluminium conductor during crimping. Secondly, the slots 20 enable portions of the outer surface of the conductor to come into contact with the inner surface of the cavity 3 in the body portion 6. This promotes good electrical contact between the conductor and body portion.

A further advantage lies in the fact that it is possible to make the walls of the body portion 6 thicker, due to the thinness of the walls of the sleeve 1A. This also has advantageous effects as far as electrical connection is concerned. If the wall of the body portion is too thin problems with crimping can occur because of aluminium creep. By providing thicker walls, a better electrical connection following crimping is generally assured.

It will be appreciated by persons skilled in the art that numerous variations and/or modifications may be made to the invention as shown in the specific embodiments

without departing from the spirit or scope of the invention as broadly described. The present embodiments are, therefore, to be considered in all respects as illustrative and not restrictive.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. An electrical connector for connecting an end of a power conductor to another member, comprising a first part having a passageway therein for receiving the end of a power conductor, and a second part arranged to be connected to the other member, the first and second parts being electrically connectable and being rotatable relative to each other, the second part comprising a first portion adapted to be connected to the other member and a second portion comprising a body portion having a cavity extending therein, the first part comprising a sleeve which is shaped and configured to fit into the cavity and to be rotatable therein through a range of positions, the passageway in the sleeve being shaped and dimensioned to accommodate the end portion of an electrical power conductor, whereby to enable a power conductor having a first orientation to be connected to another member having a second orientation, the sleeve having a plurality of abrasive surfaces within the passageway whereby to assist in removing oxide from the surface of the conductor during crimping.

2. An electrical connector in accordance with claim 1, the cross-sectional shape of the passageway within the sleeve being different from the cross-sectional shape of the external surface of the body portion, whereby the cross-sectional shape of the external surface of the body portion may be suited for use with particular crimping tools and the internal cross-sectional shape of the passageway in the sleeve may be suited to electrical power conductors of particular cross-sectional shapes.

3. An electrical connector in accordance with claims 1 or 2, the sleeve being seated within the cavity in the body portion and being retained within the cavity by a conductive grease.

4. An electrical connector in accordance with claims 1, 2 or 3, the sleeve being provided with a plurality of slots extending axially along at least the internal surface thereof, the corners of the slots providing the abrasive surfaces.

5. An electrical connector in accordance with claim 4, the slots forming slits which extend through the walls of the sleeve, whereby during crimping the conductor may contact the walls of the cavity in the body portion.

6. An electrical connector in accordance with any one of the preceding claims, the walls of the body portion being relatively thick at least compared with the walls of the sleeve, whereby to facilitate crimping performance.

7. An electrical connector in accordance with any one of the preceding claims, wherein the first portion of the second part comprises a further body portion having a passage therein shaped and dimensioned to accommodate an end of an electrical power conductor, whereby to enable connection between respective ends of respective electrical power conductors.

8. An electrical connector in accordance with claim 7, wherein the further body portion has a cavity therein arranged to receive a further sleeve portion having a passageway therein shaped and dimensioned to accommodate the electrical power conductor, the further sleeve portion being rotatable relative to the further body portion.

9. A method of electrically connecting an end of a power conductor having a first orientation to another member having a second orientation, comprising the steps of providing an electrical connector comprising a body having a first portion adapted to be connected to the other member and a second portion comprising a body portion having a cavity extending therein, and a sleeve shaped and configured to fit into the cavity and to be rotatable therein through a range of positions, the sleeve having a passageway therein shaped and dimensioned to accommodate the end of the electrical power conductor and the sleeve having a plurality of abrasive surfaces within the passageway whereby to assist in removing oxide from the surface of the conductor during crimping, placing the end of the electrical power conductor within the passageway in the sleeve, rotating the sleeve relative to the body portion if there is any difference between the first and

second orientations to take into account the difference between the first and second orientations, crimping the body portion of the connector and the sleeve to the end of the power cable, and securing the first portion to the other member to provide an electrical connection.

10. A method in accordance with claim 9, the end of the electrical power conductor being of a different cross-sectional shape from the outer surface of the body portion of the connector, and the passageway within the sleeve conforming to the cross-sectional shape of the power cable end.

11. An electrical connector, substantially as described herein, with reference to any one embodiment as illustrated in the accompanying drawings.

12. A method of electrically connecting an end of a power conductor having a first orientation to another member having a second orientation, substantially as herein described, with reference to any one embodiment as illustrated in the accompanying drawings.

Dated this 24th day of June 1998

UTILUX PTY LIMITED
By their Patent Attorney
GRIFFITH HACK & CO.

ABSTRACT

ELECTRICAL CONNECTOR

The present invention relates to an electrical connector for connecting power transmission conductors to, in particular, power distribution boards or other power transmission conductors.

The connector comprises a first end portion comprising a cylindrical body having a bore therein, a sleeve rotatably mounted within the bore and having a passage therein for receipt of an end of a power conductor. The second end portion of the connector is adapted to be secured to a distribution board or to another conductor.

The sleeve is rotatable within the connector to enable a conductor of a first orientation to be fixed to a power distribution board or conductor of a second orientation without having to twist the conductor having the first orientation.

74379/94

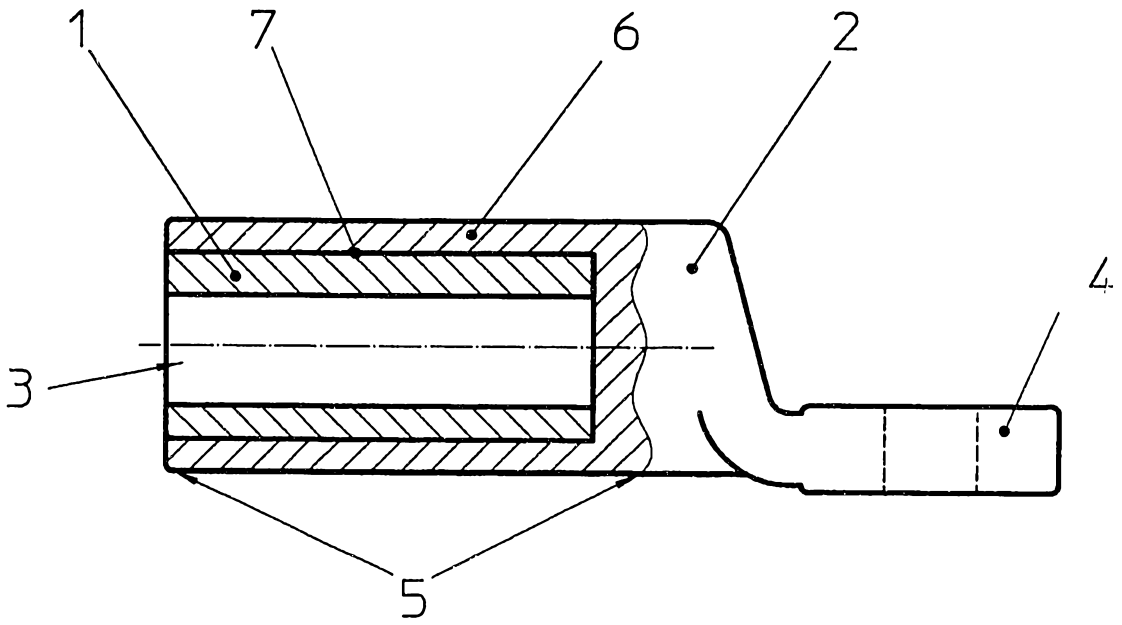

FIGURE 1

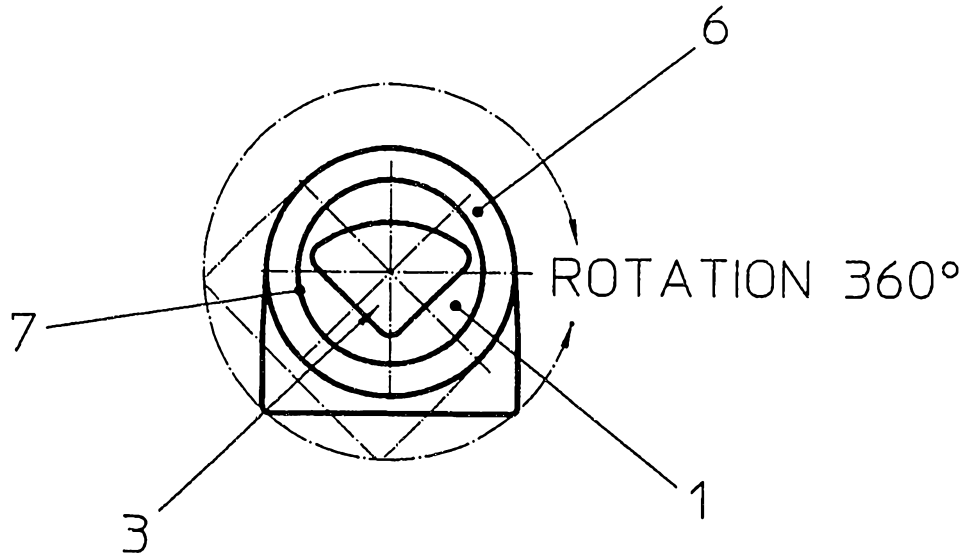

FIGURE 2

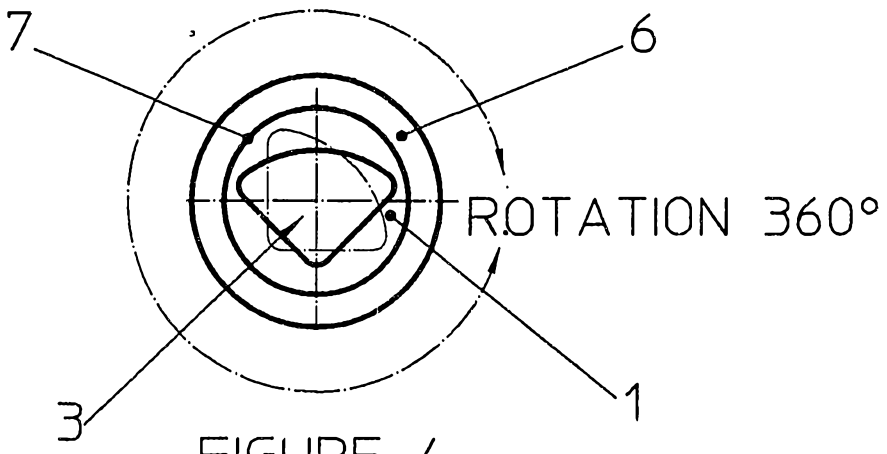

FIGURE 4

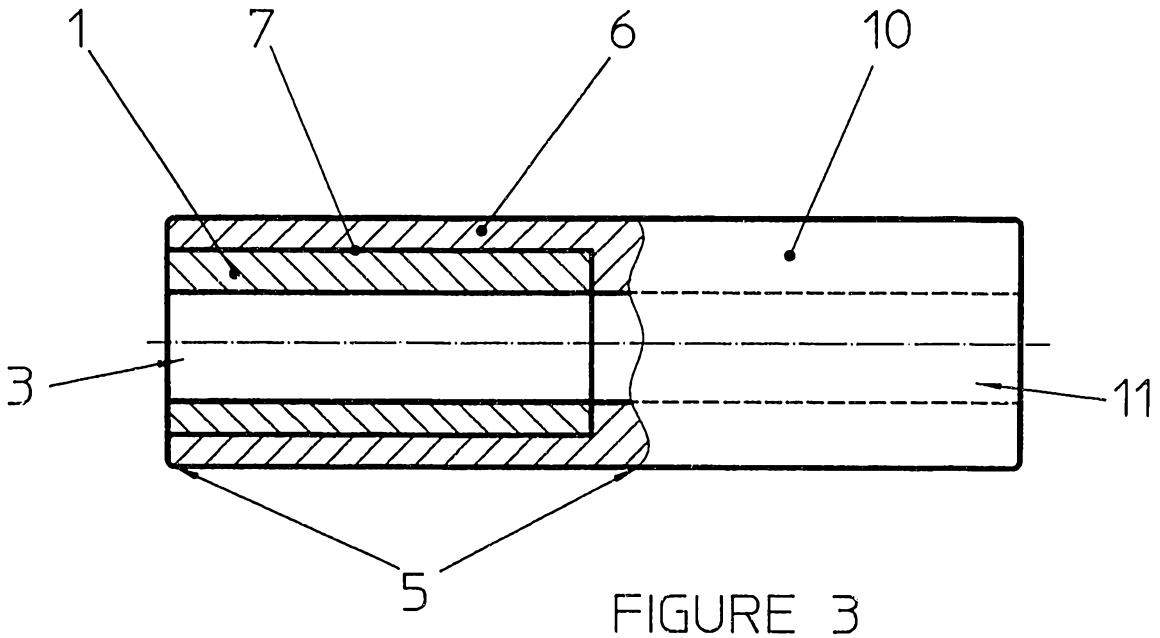

FIGURE 3

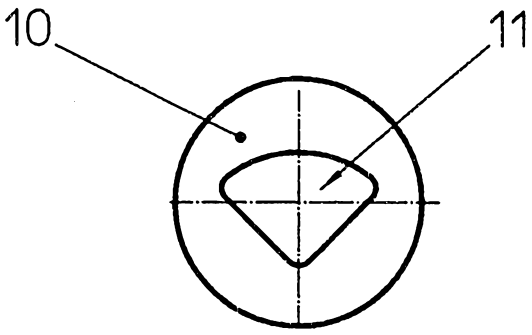

FIGURE 5

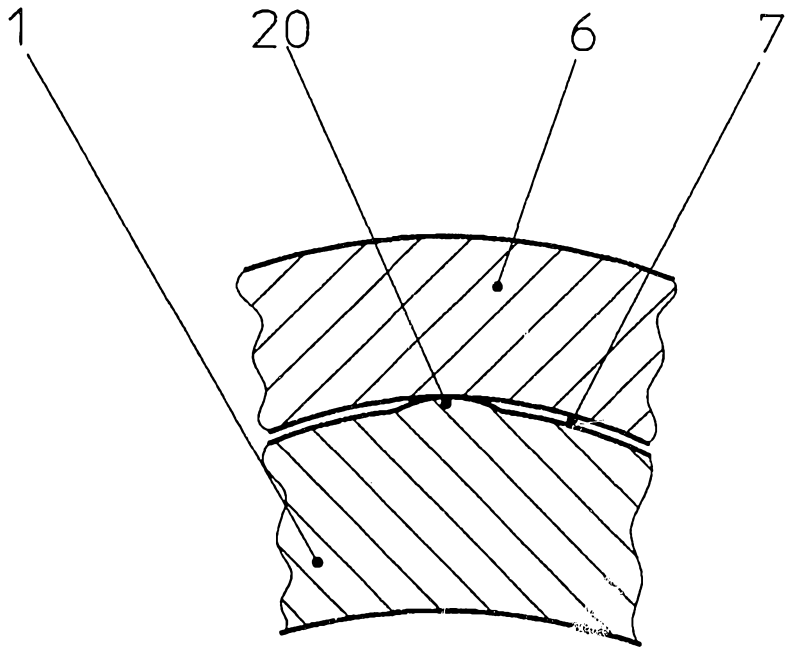

FIGURE 6

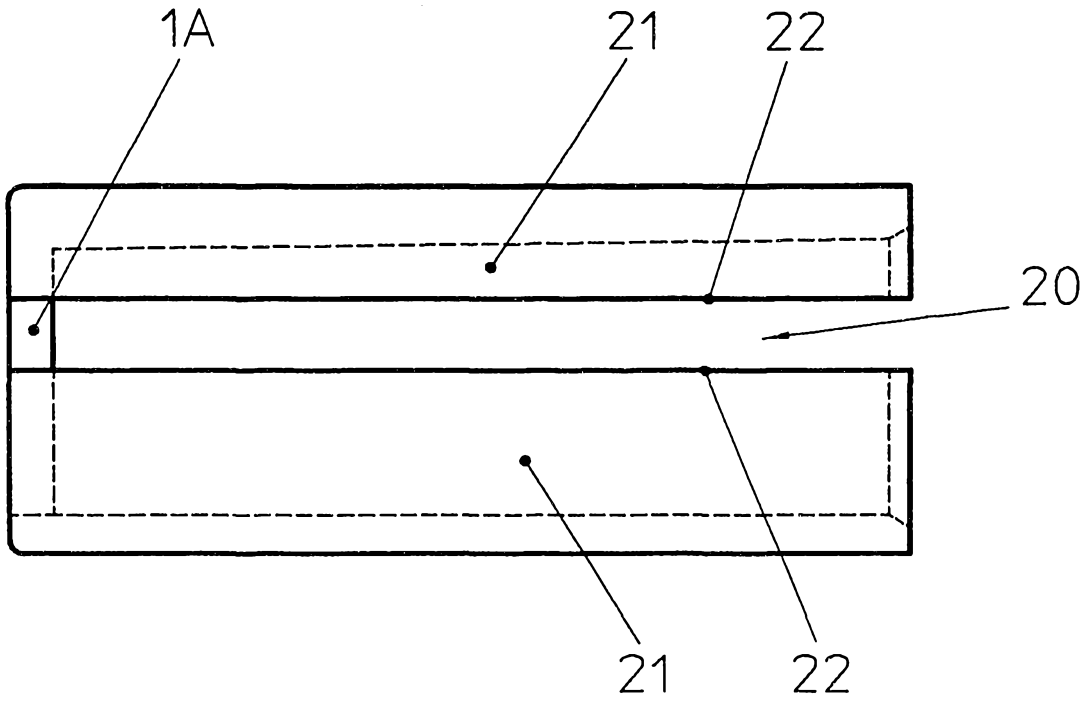

FIGURE 7

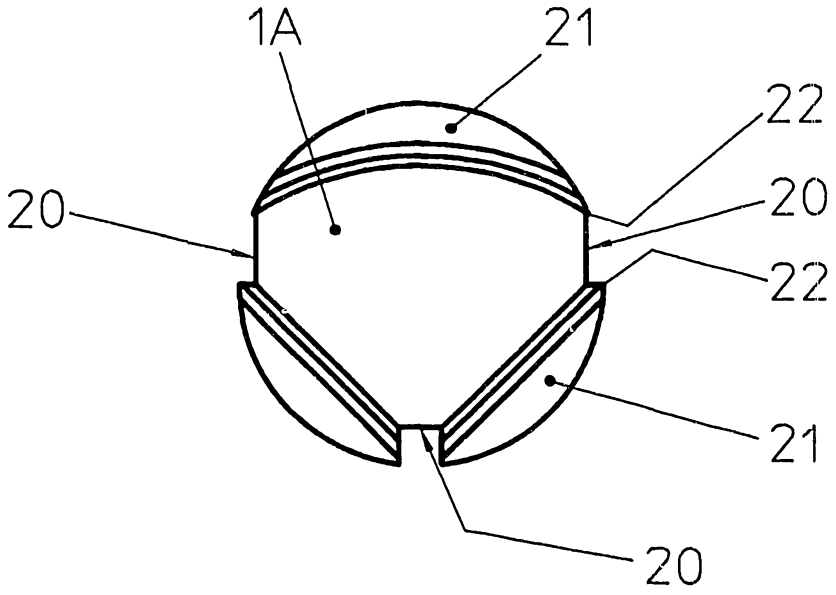

FIGURE 8